

Governance Model in Action: The New Horizons RP-1 Tank Decision

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NASA Academy Case Study Initiative

Masters Forum

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New Horizons Overview



- First mission to Pluto
- Planned launch in mid-January 2006

Project management challenge:
Schedule driven by short launch window – Jupiter gravity assist in February 2007 will shave years off mission



Launch Date (2006)

Jan. 17-27
Jan. 28
Jan. 29-31
Feb. 1-2
Feb. 3-8
Feb. 9-12
Feb. 13-14

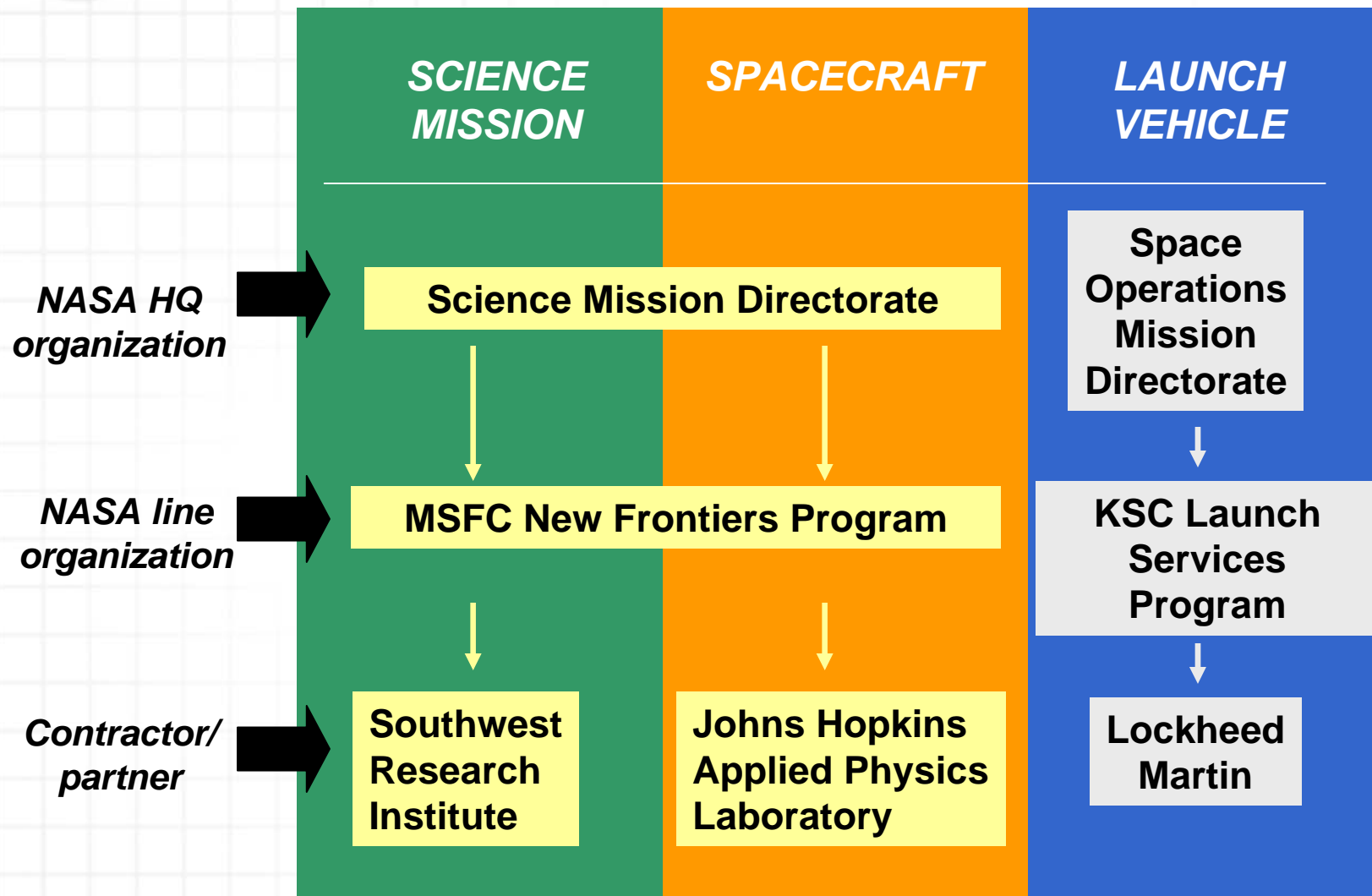
Pluto Arrival (close approach)

July 14, 2015
August 15, 2015
July 12, 2016
July 11, 2017
July 10, 2018
June 7, 2019
July 20, 2020

(Chart source: JHU/APL Mission Guide)



Complex Organizational Structure





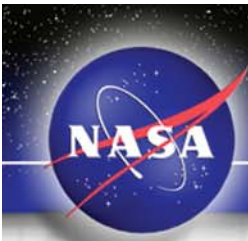
RP-1 Tank Fails during Qualification Testing



Mid-September 2005

- Atlas V launch vehicle – first NASA use of heavy configuration requires re-qualification of flight hardware
- Catastrophic failure during final stages of qualification testing of Atlas V RP-1 fuel tank





Multiple Lines of Inquiry



Failure investigated by contractor, KSC Launch Services Program (LSP), KSC S&MA, and NASA Engineering Safety Center (NESC)

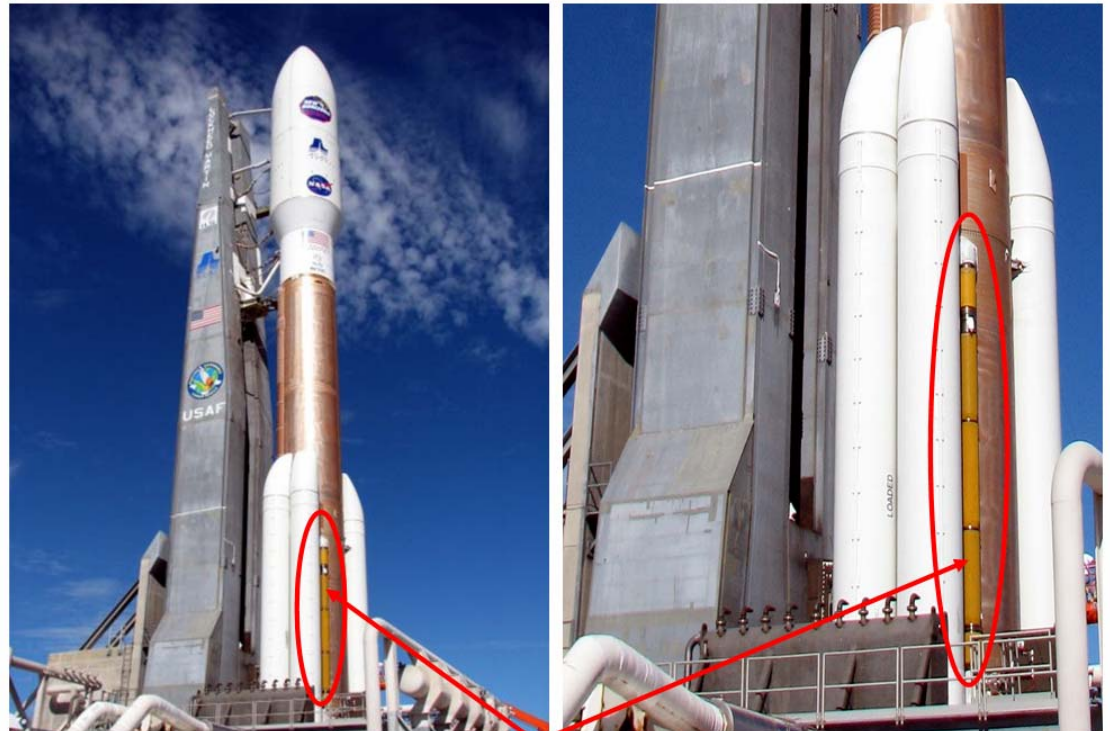
		Administrator/Associate Administrator		
		PROGRAM AUTHORITY	SAFETY & MISSION ASSURANCE	ENGINEERING TECHNICAL AUTHORITY
Headquarters (Cross-agency)		Space Operations Mission Directorate	Safety & Mission Assurance	Office of the Chief Engineer ↓
				NESC matrixed to support KSC S&MA
Center level		KSC Launch Services Program	KSC S&MA	



The Technical Problem



- Problem isolated to inner tank wall near LO_2 feed line
- Cracks discovered in pre-test photos of qualification tank
- All existing RP-1 tanks in fleet investigated
- Extensive materials and structural analyses conducted



LO_2 feed line



Same Problem, Different Answers



Nov-Dec. 2005: Shared preliminary conclusions

- RP-1 tank employed marginal design
- Not possible to fly fully qualified flight hardware in Jan. '06

KSC LSP proposes mitigations

- Borescope investigation of flight tank show no signs of problems
- Proposes altered flight profile to minimize loads at key points during ascent

KSC S&MA and NESC want more time to investigate

- Problems with most other tanks in fleet – cracks
- More data required from contractor
- Risk to mission success unacceptably high



The Nuclear Factor



Nuclear Power Supply Affects the Equation

- *Almost no chance of public safety hazard*
 - Extremely resilient design with long track record
 - Most likely failure would occur over ocean with no radiation release
- *High certainty of public relations disaster if launch fails*



☒ Requires White House approval



Final Flight Planning Board Meeting



- Differences of opinion presented at 1/10/06 Flight Planning Board meeting
 - AA for Space Ops (Chair)
 - Chief Engineer
 - Chief Officer of Safety & Mission Assurance
 - AA of Science Mission Directorate
 - Director of Kennedy Space Center
- Nearly 30 attend meeting, others via telecon
- Administrator and Associate Administrator invited — dissenting votes anticipated.



Go/No-Go



GO

- Flight tank visually inspected twice and found flawless.
- Mission profile tailored to minimize possibility of launch failure over land.
- Failed qualification tank already cracked when testing process began.
 - Survived until final stages of testing with cracks.
- Perfect tank would have adequate margin under the specific flight conditions for this mission.

NO-GO

- Tank not fully qualified flight hardware.
- Inadequate design that had failed catastrophically
- Flight rationale offered based solely on flight tank evidence
- Failure mechanisms and margin not established by traditional validation practices.
- Not been enough time to develop necessary models to determine failure mechanisms and margin.



Governance Model in Action



- Launch Services, S&MA, and NESC present points of view
- Opinions solicited from others in attendance
- Chair polls Flight Planning Board voting members –
2 “delay” votes
 - Chief S&MA Officer
 - Chief Engineer
- Dissent triggers automatic appeal by Chair to Administrator...



Decision Time

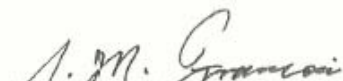


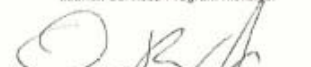
- **Administrator reviews the situation:**
 - Lack of qualified flight hardware: from a formal process standpoint, NASA flies only qualified hardware.
 - Good engineering requires judgment: is this particular tank suitable to fly?
- **and the evidence:**
 - Qualification tank had survived very rigorous testing with cracks up to ~95% of its final test.
 - Flight tank exhibited superior material properties to qualification tank, and had been inspected and found crack-free.
 - Flight tank would withstand much lower pressures than qualification tank in testing.
 - RTG release of nuclear material in the event of launch failure not a credible concern.
- **Decides in favor of program's position to proceed.**



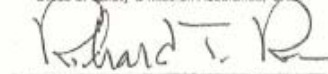
Launch Readiness Certification AV-010 Pluto New Horizons Launch Vehicle

At the AV-010 Pluto New Horizons Launch Readiness Review, the following organizations certified that the necessary prelaunch operations related to their areas of responsibility have been satisfactorily completed to date. As of this Launch Readiness Review, there are no launch constraints related to their areas of responsibility. The launch vehicle, spacecraft, and all supporting systems as applicable, are ready for flight, pending satisfactory closure of remaining tasks and open items identified in this review.


Steve Francia, NASA Kennedy Space Center
Launch Services Program Manager


Omar Booz, NASA Launch Services Program
Launch Director


Bryan O'Connor, NASA
Office of Safety & Mission Assurance, Chief


Dr. Richard Roca, Applied Physics Laboratory
Johns Hopkins University, Director


Dr. Alan Stern, Southwest Research Institute
New Horizon Principal Investigator



ILS



ATLAS

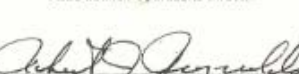
LOCKHEED MARTIN


Brig. Gen. Mark Owen, United States Air Force
45th Space Wing Commander


Mike Jensen, International Launch Services
Vice President, Technical Operations


Ann K. Widdgen, International Launch Services
PNH Program Director


Jerry Jamison, Lockheed Martin Space Systems
Atlas Launch Operations Director


Robert J. Reynolds, Lockheed Martin Space Systems
Atlas Recurring Launch Operations Director


Anthony Nardo, Lockheed Martin Space Systems
PNH Integration Manager





The Flight Planning Board understands the residual risk associated with the AV-010 RP-1 tank and the mitigations taken by the Launch Service Contractor and Launch Services Program's engineering staff. In the view of the Flight Planning Board Chairman, the risk from the RP-1 tank is understood and acceptable. The Flight Planning Board recognizes the independent risk ratings provided by the Program's technical team and the SMA/NESC. The efforts in mitigating the risk and rationale for the flight provide for the highest practical probability of mission success for the New Horizon mission.

NASA Administrator

10 Jan 2006

10 JAN 2006



Conclusions



The governance model worked

1. Dissenting opinions presented in atmosphere of mutual respect.
2. All views aired at final Flight Planning Board meeting, even those of non-voting members.
3. Transparent decision-making process.
4. Set governance precedent for similar decisions (STS-121 ice/frost ramp).

